

OVERVIEW OF THE NUSHAGAK-MULCHATNA CHINOOK SALMON FISHERIES.
WITH EMPHASIS ON THE SPORT FISHERY

REPORT TO THE ALASKA
BOARD OF FISHERIES



by

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INTRODUCTION

The Nushagak River drains an extensive portion of the Bristol Bay watershed and empties into Nushagak Bay, near Dillingham (Figure 1). The Nushagak River is the largest producer of chinook salmon in Bristol Bay. Since 1966, returns of chinook salmon ranged from 72,000 to 356,000 fish, but most (75%) were between 100,000 and 200,000 chinook (Table 1). During the period 1978 through 1983, a period of record returns (average 288,500 chinook salmon) occurred. From 1986 to 1990, run sizes were low (average 106,000) but since 1991, run size has increased. Chinook salmon stocks in the Nushagak-Mulchatna drainage are presently considered to be stable at average levels.

Peak production in the early 1980s resulted in record commercial harvests and development of a growing sport fishery. Declining run sizes and the question of how to share the burden of conservation among users precipitated the development of a management plan for Nushagak chinook salmon. Since 1992, management of the Nushagak chinook salmon fisheries has been governed by the Nushagak-Mulchatna Chinook Salmon Management Plan (NCSMP) (5 AAC 06.361), adopted by the Alaska Board of Fisheries in January 1992, and amended in January of 1995.

The purpose of this management plan is to ensure an adequate spawning escapement of chinook salmon into the Nushagak-Mulchatna River system. The plan directs the department to manage the commercial fishery for an inriver run goal of 75,000 chinook salmon past the sonar site at Portage Creek. The inriver goal provides for: (1) a biological escapement goal (BEG) of 65,000 spawners, (2) a reasonable opportunity for inriver subsistence harvest, and (3) a sport guideline harvest of 5,000 fish.

The plan addresses poor return scenarios by specifying management actions to be taken in subsistence, commercial, and sport fisheries depending on the severity of the conservation concern (Figure 2). Management decisions are heavily dependent upon the cumulative estimates of inriver passage generated from the Portage Creek sonar site. The 1997 season was the fifth year the department has managed under this plan.

This report presents the results of an analysis of the current BEG, reviews management performance of the Nushagak River chinook fisheries under the NCSMP and presents a summary of the 1997 fishing season.

BIOLOGICAL ESCAPEMENT GOAL (BEG) ANALYSIS

Chinook escapements into Nushagak River were estimated with aerial surveys from 1966-1985 and 1997 and with side-scan sonar from 1986-1997. Annual runs were the sum of aerial or sonar counts and harvests by commercial, sport and subsistence fisheries. Sport and subsistence harvests above the Nushagak River sonar site were subtracted from the escapement past the sonar site to estimate number of spawners (Minard et al. 1992). We assumed that chinook salmon harvested in Nushagak District originated from rivers within the district.

SPAWNER-RETURN ANALYSIS

Chinook salmon spawner-return data were analyzed for brood years 1966-1991 for Nushagak River. Return information for brood year 1991 is incomplete because 7-year-old chinook

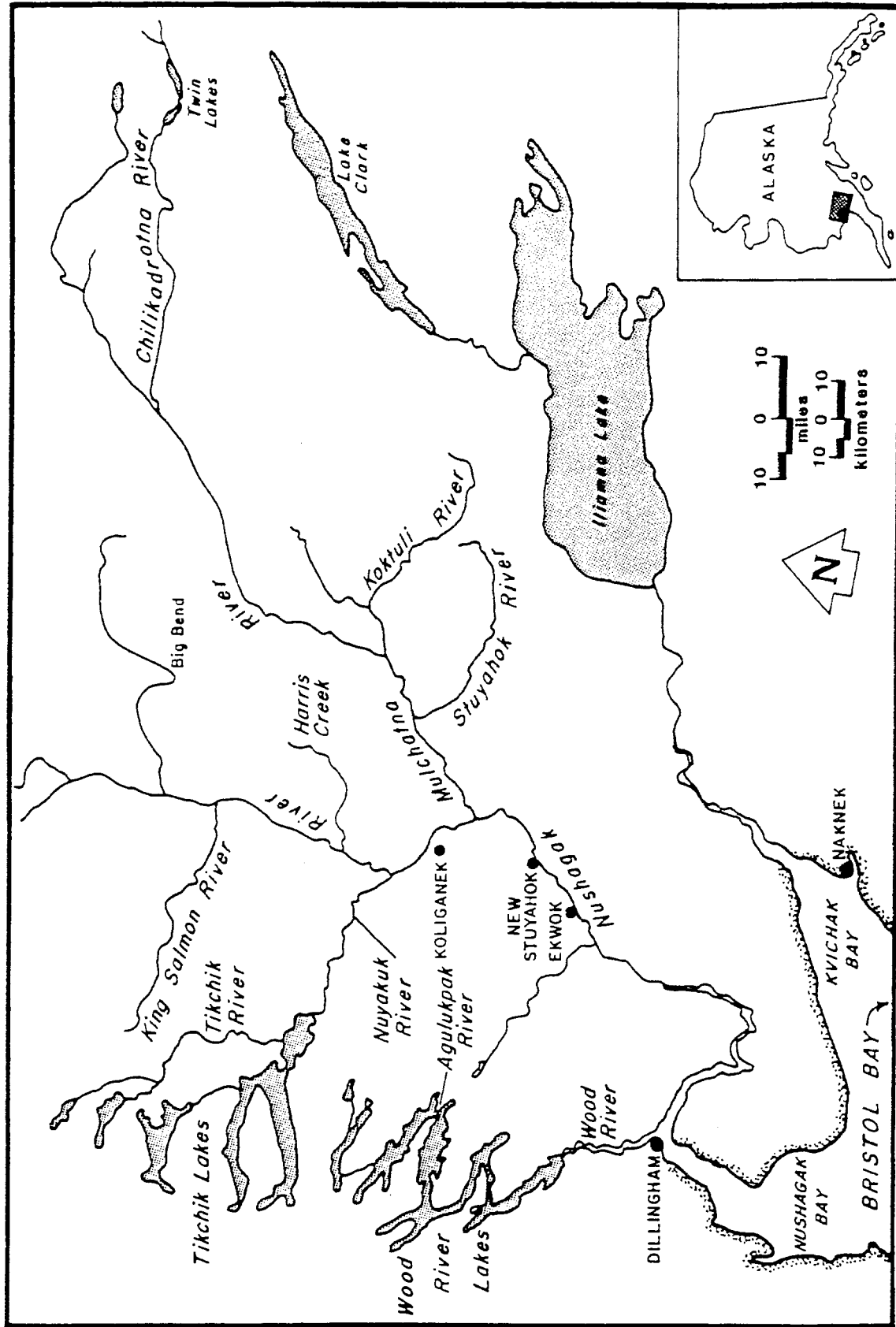


Figure 1.-Nushagak and Mulchatna River drainages, Bristol Bay.

Table 1.-Chinook salmon commercial, subsistence, and sport harvest, plus escapement and total run for the Nushagak drainage, 1966-1977.

Year	Commercial	Subsistence	Sport Harvest			Total	Spawning	Total
	Harvest	Harvest	Nush ^a	Mul ^b	Total	Harvest	Escapement ^c	Run
1966	58,184	3,700				61,884	40,000	101,884
1967	96,240	3,700				99,940	65,000	164,940
1968	78,201	6,600				84,801	70,000	154,801
1969	80,803	7,100				87,903	35,000	122,903
1970	87,547	6,300				93,847	50,000	143,847
1971	82,769	4,400				87,169	40,000	127,169
1972	46,045	4,000				50,045	25,000	75,045
1973	30,470	6,600				37,070	35,000	72,070
1974	32,053	7,900				39,953	70,000	109,953
1975	21,454	7,100				28,554	70,000	98,554
1976	60,684	6,900				67,584	100,000	167,584
1977	85,074	5,200	402	521	923	91,197	65,000	156,197
1978	118,548	6,600	151	291	442	125,590	130,000	255,590
1979	157,321	8,900	312	342	654	166,875	95,000	261,875
1980	64,958	11,800	611	146	757	77,515	141,000	218,515
1981	193,461	11,500	929	291	1,220	206,181	150,000	356,181
1982	195,287	12,100	1,436	367	1,803	209,190	147,000	356,190
1983	137,123	11,800	1,615	388	2,003	150,926	161,730	312,656
1984	61,378	9,800	1,534	786	2,320	73,498	80,940	154,438
1985	67,783	7,900	1,546	292	1,838	77,521	115,720	193,241
1986	65,783	12,600	1,780	3,534	5,314	83,697	35,200	118,897
1987	45,983	12,428	1,398	1,860	3,258	61,669	78,224	139,893
1988	16,648	10,187	2,414	403	2,817	29,652	50,834	80,486
1989	17,637	8,122	2,859	754	3,613	29,372	73,147	102,519
1990	14,812	12,407	1,674	1,409	3,083	30,302	57,629	87,931
1991	19,718	13,627	3,657	1,894	5,551	38,896	96,449	135,345
1992	47,563	13,588	3,866	889	4,755	65,906	76,512	142,418
1993	62,976	17,709	4,916	983	5,899	86,584	88,687	175,271
1994	119,480	15,490	8,931	1,695	10,626	145,596	83,408	229,004
1995	79,943	13,701	4,549	402	4,951	98,595	74,803	173,398
1996	72,011	15,941	2,016	128	2,144	90,096	44,628	134,724
All Years Avg.	74,772	9,539	2,330	869	3,199	87,509	78,900	166,410
Percent	85%	11%			4%			
1992-1996 Avg	76,395	15,286	4,856	819	5,675	97,355	73,608	170,963
Percent	78%	16%			6%			
1997	64,294	15,000	2,000	500	2,500	81,794	82,000	163,794
Percent ^d	79%	18%			3%			

^a Nushagak River and tributaries excluding the Mulchatna River and tributaries.

^b Mulchatna River and tributaries.

^c Inriver abundance (as reported by ADF&G, CFMD) minus subsistence and sport harvest above sonar.

^d 1997 harvest estimates are preliminary. 1997 escapement estimate based on aerial surveys.

NUSHAGAK-MULCHATNA

Projected Inriver Return (sonar count)	SUBSISTENCE	SPORT	COMMERCIAL
	Normal Subsistence Fishery		Directed Fishery large mesh allowed
Inriver Goal	75,000	5,000 fish guideline	Close Directed Fishery
Biological Goal	65,000	Restrict Fishery	5.5" mesh or less
			Close Chinook and Sockeye Fishery
	Time and Area Restrictions	Closed	until Wood R. esc. exceeds 100,000

Figure 2.-Graphic depiction of the Nushagak-Mulchatna Chinook Salmon Management Plan.

salmon will not return until 1998. Since this age group generally does not comprise a large percent of the total return, age-1.5 returns were estimated based on returns of age-1.4 (siblings) chinook salmon from the 1991 brood year and the historic relationship between age-1.4 and age-1.5 chinook salmon. As was done for sockeye salmon (Cross et al. 1997), Ricker stock-recruitment models (Ricker 1975) were fitted to chinook spawner-return data to estimate the number of spawners required to produce maximum sustained yield (MSY). Results were not used if the model fit to the data was poor or model assumptions were violated.

The numbers of chinook spawners ranged from 25,000 in 1972 to 162,000 in 1983 (Table 2 and Figure 3). The average number of spawners during the last 10 years was 73,000 chinook salmon. Chinook returns ranged from 49,000 for brood year 1969 to 476,000 for brood year 1977. Return-per-spawner values varied from a low of 0.5 for brood year 1982 to a high of 9.2 for brood year 1972 and averaged 2.8 for all available brood years (Table 2 and Figure 4). Nushagak River chinook spawner-return data showed evidence of density dependent mortality as return-per-spawner values were lower for escapements greater than 100,000.

Chinook spawning escapements ranging from 40,000-100,000 have, on average, produced large returns (Figure 5). The number of chinook spawners needed to maintain the average Nushagak River run based on the average return-per-spawner value is 60,000 spawners (Table 3). A Ricker stock-recruitment model fitted through all available brood years was significant ($P=0.0001$) and estimated the number of spawners required to produce MSY was 50,000 (Table 3 and Figure 6). A Ricker stock-recruitment curve fitted through spawner-return data estimated from aerial surveys only (1966-1979) was significant ($P=0.09$) and estimated that 65,000 spawners would produce MSY. A model was fitted through aerial survey data only because we were unsure how the mixture of aerial and sonar data would affect the spawner-return relationships. There were not enough brood years to estimate a stock-recruitment model from only sonar information.

YIELD ANALYSIS

The tabular approach used for sockeye salmon (Cross et al. 1997) was also used to examine chinook salmon stock-recruitment relationships. This method provided information on the proportion of times a spawning population size within a specific interval produced a recruitment within each recruitment interval as well as the average yield within each interval.

Average surplus yield was greatest (135,000) from spawning escapements ranging from 40,000-65,000 for which there were seven observations (Figure 7). The six spawning escapements greater than 100,000 chinook salmon did not on average produce any surplus yield. Spawning escapements ranging from 25,000-40,000 (four observations) and 70,000-100,000 (nine observations) produced similar average yields. Spawning escapements from 40,000-100,000 chinook salmon produced similar average yields.

ESCAPEMENT QUALITY

The trend in age composition of chinook spawning escapements in 1995 and 1996 raised concerns about the quality of chinook escapements into the Nushagak River (Table 4 and Figure 8).

Table 2.-Nushagak River chinook salmon spawners and returns by brood year, 1959-1966.

Brood Year	Spawners	Returns By Age Class					Total Return	Return/Spawner
		1.1	1.2	1.3	1.4	1.5		
1959						1.833		
1960					48.853	8.115		
1961				33.756	70.559	13.746		
1962			16.739	43.677	76.254	6.977		
1963			35.681	48.497	65.179	3.309	158,309	
1964			9.269	31.565	33.141	876	80,119	
1965		761	14,242	83,564	83,778	3,481	188,675	
1966	40,000	62	13,979	27,454	38,557	5,044	99,210	2.48
1967	65,000	0	9,795	16,353	46,066	24,552	99,885	1.54
1968	70,000	0	13,485	18,291	67,765	8,368	109,661	1.57
1969	35,000	0	965	14,524	29,429	2,430	49,038	1.40
1970	50,000	0	1,385	56,699	73,517	4,043	138,688	2.77
1971	40,000	0	2,433	55,755	94,828	12,572	174,720	4.37
1972	25,000	0	33,264	52,295	125,392	7,275	229,380	9.18
1973	35,000	0	2,204	82,126	105,777	13,089	203,196	5.81
1974	70,000	0	23,817	42,053	51,264	2,174	124,992	1.79
1975	70,000	587	95,530	146,534	137,063	9,963	400,440	5.72
1976	100,000	1,576	7,628	111,415	143,981	6,052	281,479	2.81
1977	65,000	0	96,260	152,290	208,444	14,837	475,536	7.32
1978	130,000	1,738	27,569	46,773	56,434	22,029	155,055	1.19
1979	95,000	3,137	49,377	70,843	87,467	11,862	223,375	2.35
1980	141,000	205	11,241	48,427	56,050	3,045	119,407	0.85
1981	150,000	967	33,684	45,639	83,045	7,328	170,944	1.14
1982	147,000	1,494	3,770	35,480	31,861	5,760	78,365	0.53
1983	161,730	118	17,640	20,445	51,476	1,454	91,472	0.57
1984	80,940	682	17,261	27,222	21,998	1,826	69,178	0.85
1985	115,720	3,205	17,998	37,021	44,991	2,065	105,423	0.91
1986	35,200	22	26,879	51,113	45,991	1,937	126,345	3.59
1987	78,244	514	36,480	54,921	69,535	5,019	166,645	2.13
1988	50,834	688	36,480	62,020	105,743	2,088	207,225	4.08
1989	73,147	2,138	40,969	84,848	85,773	3,422	217,459	2.97
1990	57,629	593	31,755	34,884	33,814	678	101,696	1.76
1991	96,449	1,477	53,696	70,911	52,596		180,681	1.87
1992	76,512	914	27,244	55,041				
1993	88,687	2,151	54,191					
1994	83,408	775						
1995	79,079							
1996	45,543							
1997	82,000							
Mean								
(1966-1996)	79,160	795	28,106	56,347	74,956	7,156	169,211	2.75

Nushagak River Chinook Salmon

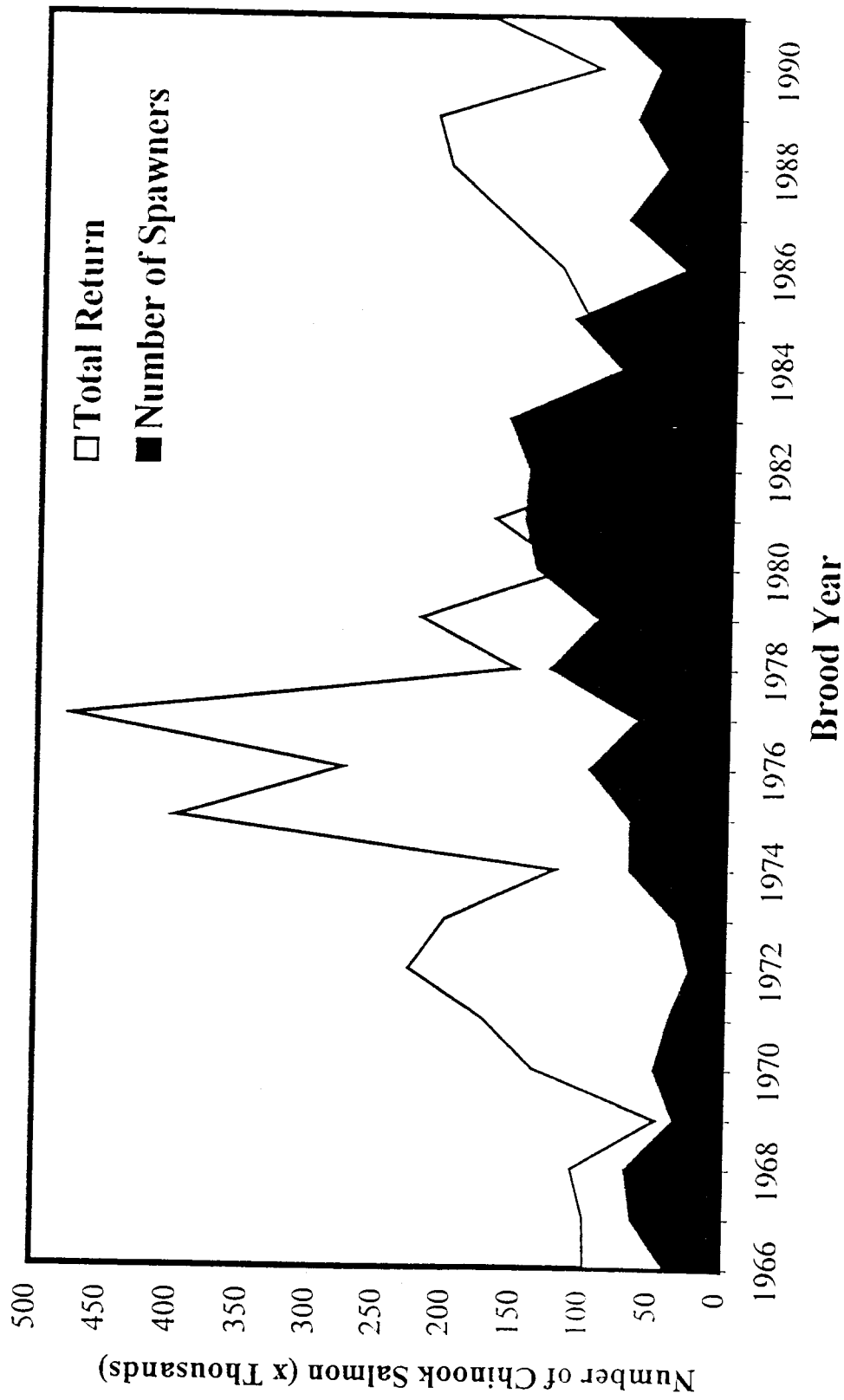


Figure 3.-Number of spawners and total return of Nushagak River chinook salmon by brood year, 1966-1991.

Nushagak River Chinook Salmon

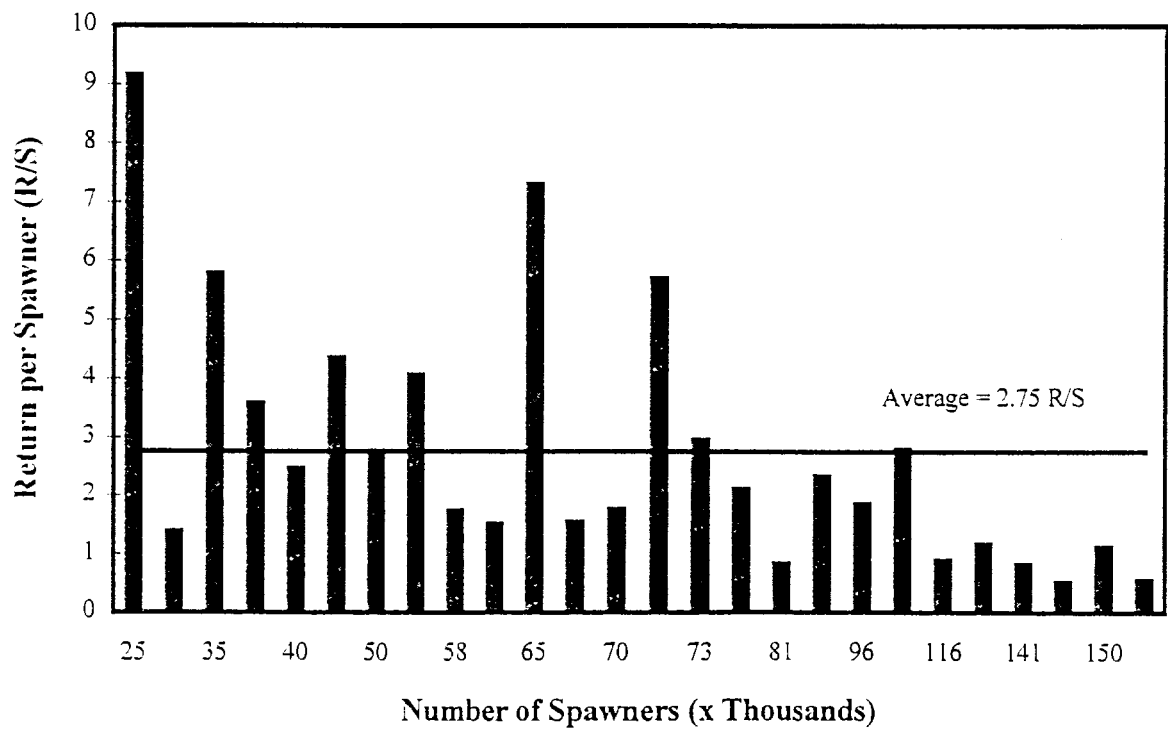
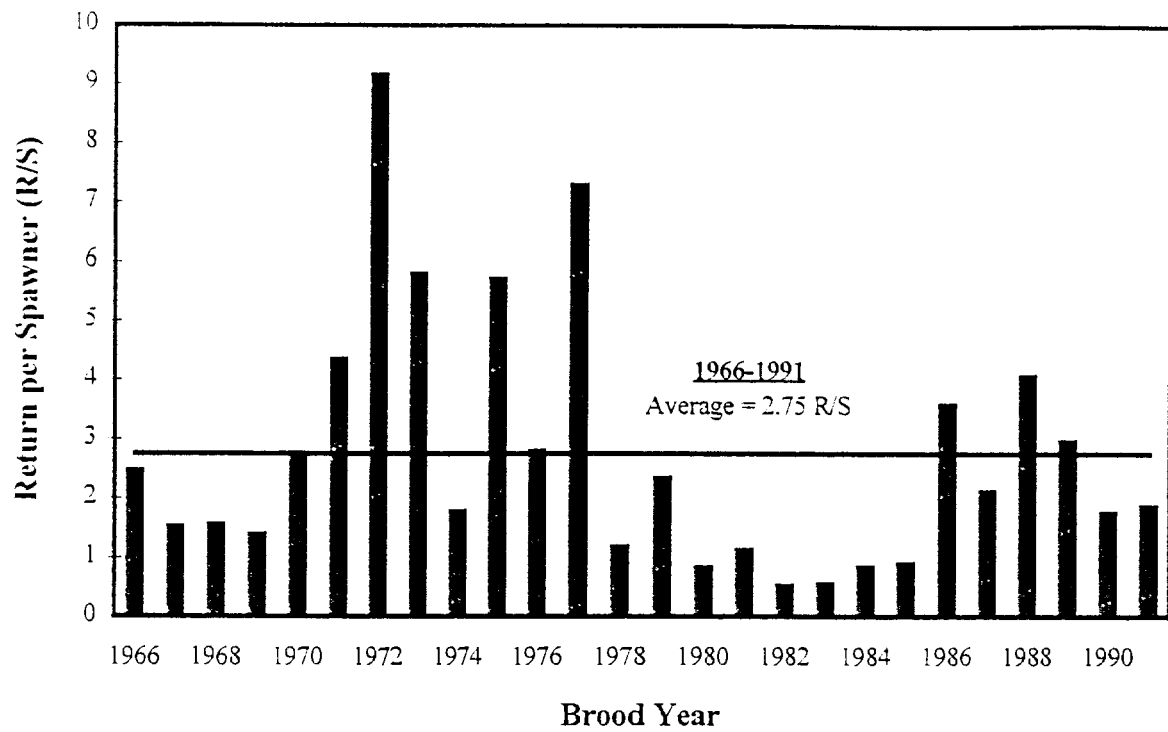


Figure 4.-Return per spawner of Nushagak River chinook salmon versus number of spawners, 1966-1991 brood years.

Nushagak River Chinook Salmon

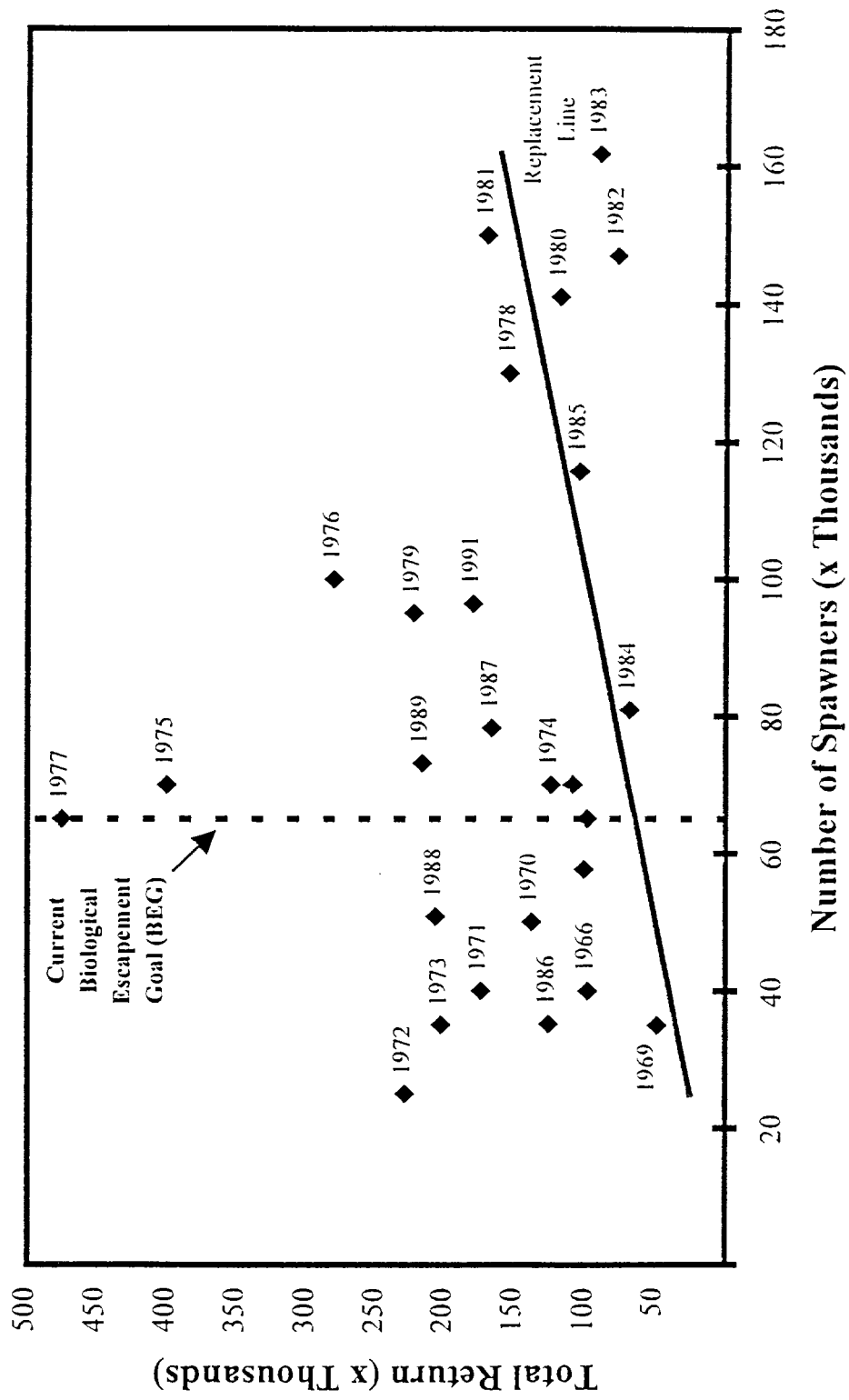


Figure 5.-Total return of Nushagak River chinook salmon versus number of spawners, 1966-1991 brood years.

Table 3.-Summary of estimated numbers of chinook salmon spawners required for high sustained yields for the Nushagak River.

Analysis	Data Base	Escapement Goal
Average Return and Average Return per spawner	1966-1991	60,000
Ricker Stock-Recruitment	1966-1991 1966-1979 Aerial	50,000 65,000
Observed Yield	1966-1991	65,000-100,000

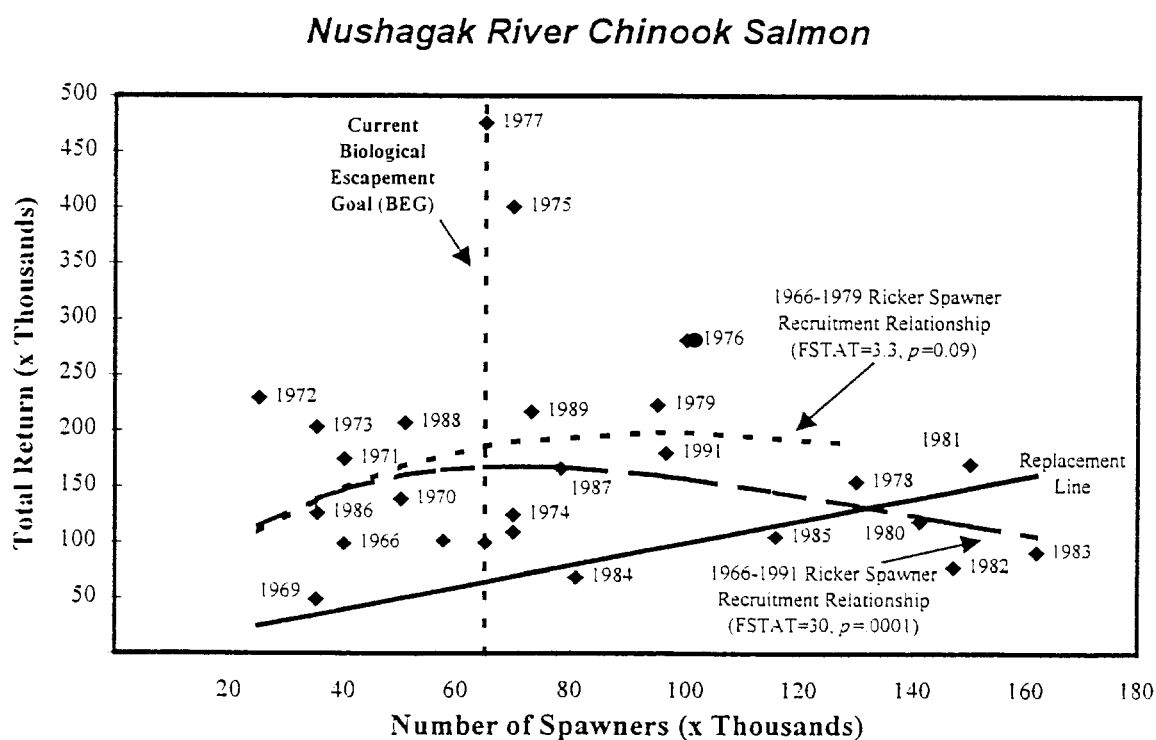


Figure 6.-Ricker spawner-recruitment relationship of Nushagak River chinook salmon, 1966-1991 brood years.

Nushagak River Chinook Salmon

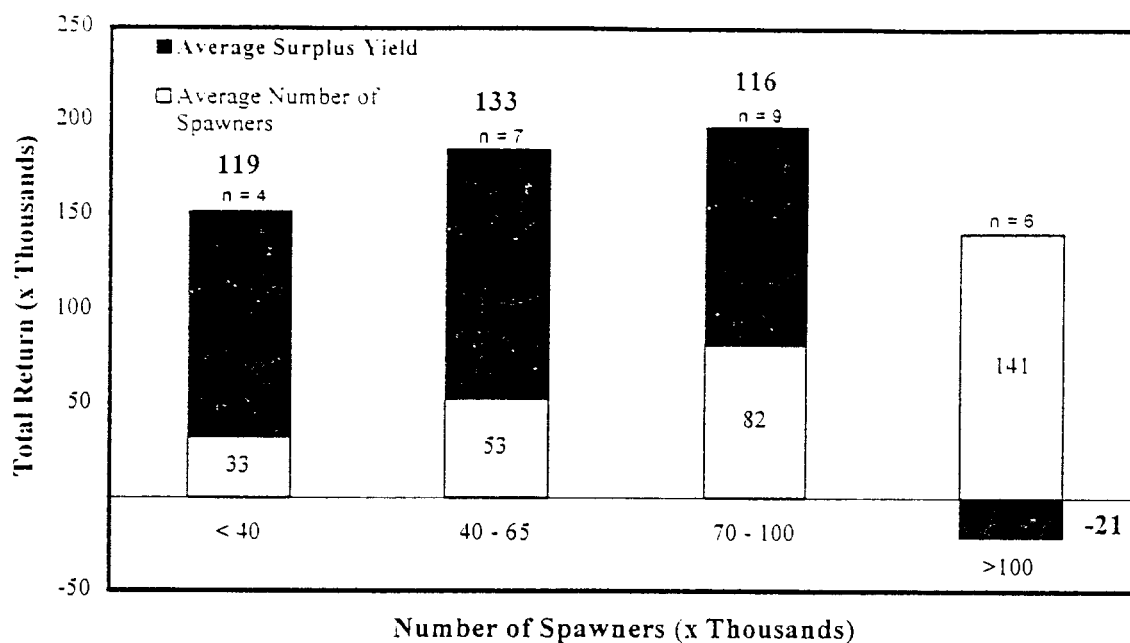


Figure 7.-Average surplus yield categorized by number of spawners of Nushagak River chinook salmon, 1966-1991 brood years.

Table 4.-Age composition of chinook salmon spawners grouped into two categories, age-3 and age-4 versus age-5 through age-7, Nushagak River 1981-1997.

Year	Age-3 and Age-4		Age-5 through Age-7		Total Number
	Percent	Number	Percent	Number	
1981	24.7	37,069	73.6	110,345	150,000
1982	7.9	1,634	89.0	130,830	147,000
1983	10.5	16,977	89.2	44,187	161,730
1984	8.2	6,613	91.7	74,214	80,940
1985	7.6	8,829	92.4	106,891	115,720
1987	11.3	8,832	88.7	69,392	78,224
1988	18.2	9,263	81.2	41,245	50,808
1989	14.5	10,575	85.5	62,530	73,105
1990	33.5	19,300	66.5	38,265	57,565
1991	29.0	27,925	70.8	68,293	96,392
1992	29.1	22,248	70.2	53,600	76,369
1993	17.9	15,846	82.0	72,636	88,588
1994	20.0	16,643	80.0	66,697	83,340
1995	40.9	32,374	58.8	46,579	79,162
1996	33.7	15,358	65.6	29,865	45,507
1997	39.2	32,157	60.8	49,843	82,000

Nushagak River Chinook Salmon

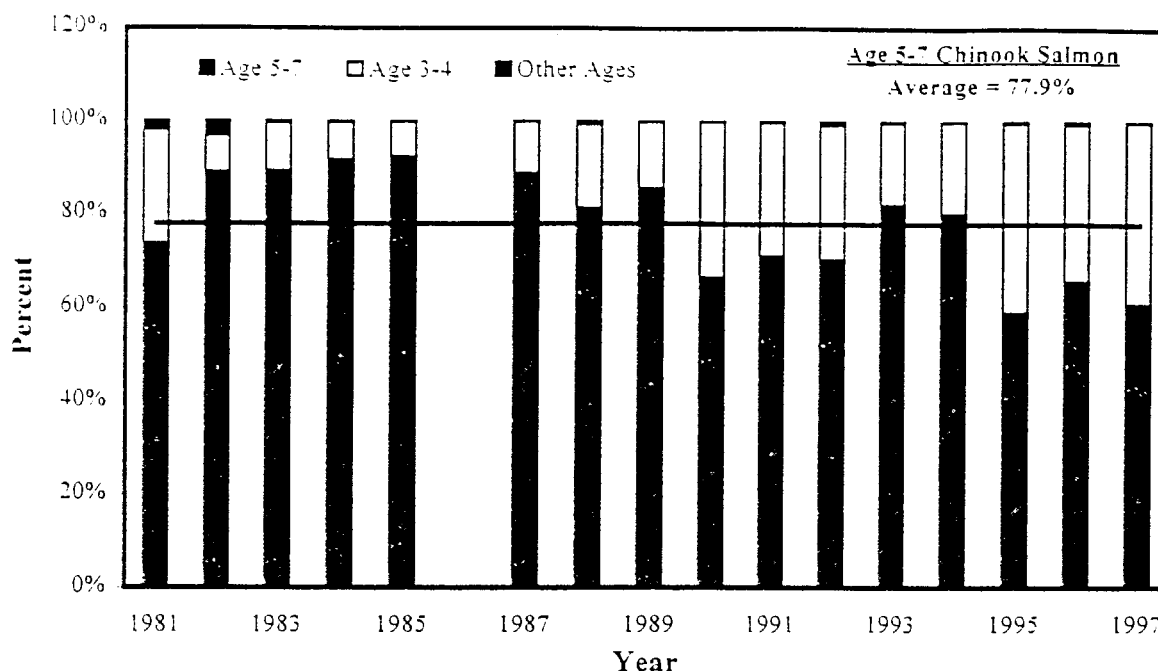


Figure 8.-Percentage of age 3-4 and age 5-7 chinook salmon in Nushagak River spawning escapements, 1981-1985 and 1987-1997.

Chinook salmon size and sex composition varies greatly as a result of their life history in which they live from 3 to 8 years. The spawning potential for a chinook salmon run depends to a large extent on the sex, age, and size structure of the fish on the spawning grounds (i.e., the spawning escapement). The smaller 3- and 4-year-old chinook returning to spawn are primarily males. The sex composition of the larger and older (age-5 through age-7) chinook salmon varies, but is approximately equal ratios of males and females. Due to the size-selective nature of commercial gillnets and size-specific bag limits in the sport fishery, both fisheries result in size-selective harvests of chinook salmon.

We reviewed the current biological escapement goal of 65,000 to determine if it adequately addressed differences in age composition observed in recent years. The average percentage that large chinook salmon (age-5 through age-7) comprised of historic spawning escapements from 1981-1991 was 82%. Age compositions from other spawning escapements were not available. Based on the current goal of 65,000 and an average percentage of 82% large fish, you would estimate that approximately 53,000 large fish should be allowed to spawn. We also compared the relationship among the number of age-5 through age-7 chinook spawners and corresponding return data for the years available, 1981-1991, and estimated the number of age-5 through age-7 spawners required to produce MSY. The age-5 through age-7 stock recruitment model was significant ($P=0.002$) and estimated that 41,000 age-5 through age-7 spawners would produce MSY. From 1981-1997 the numbers of age-5 through age-7 chinook salmon spawning were less than 41,000 during only 2 years, 1990 and 1996. The total number of spawners for those two

was also below the current biological goal of 65,000. For the 16 years we have age compositions available, the numbers of age-5 through age-7 spawners were below 53,000 during 5 years. Three of those 5 years also did not meet the current biological goal of 65,000 total spawners. Based on these results we felt the current biological goal of 65,000 addressed spawner quality adequately, although we continue to urge managers to regulate the commercial and sport fisheries to allow untouched fish through the fisheries and to secure the biological goal of 65,000 chinook spawners.

ESCAPEMENT GOAL RECOMMENDATIONS

Department staff recommend no changes for the Nushagak River chinook salmon escapement goal. Available spawner-return information supports the current biological escapement goal.

OVERVIEW OF THE SPORT FISHERY

FISHERY DESCRIPTION

The Nushagak and Mulchatna rivers supports a significant recreational chinook salmon fishery. Within the drainage, three areas of concentrated sport effort exist: the lower 12 miles of the Nushagak River near the village of Portage Creek, the middle section of the Nushagak River in the vicinity of the village of Ekwok, and the mid section of the Mulchatna River between the Stuyahok and Koktuli rivers. Although sport fishing for chinook salmon does occur in some of the tributaries of the drainage, the overall impact of that activity in terms of harvest is considered slight.

HISTORICAL PERFORMANCE

Harvest of chinook salmon by the recreational fishery has averaged 3,199 fish since 1977, and for the period 1992 to 1996 averaged 5,675 fish (Table 1). Distribution of the harvest between user groups, as shown in Table 1, indicated the majority (85%) of the harvest has historically been taken by commercial fishermen, with an additional 11% taken by subsistence fishermen, and 4% by sport fishermen.

MANAGEMENT

Sport harvest and effort are estimated through the statewide harvest survey and reported by Mills (1979-1994) and Howe et al. (1995, 1996, *In prep*). Sport Fish Division has conducted significant monitoring and stock assessment projects in the recent past (Minard 1987, Minard and Brookover 1988, Dunaway et al. 1991, Dunaway and Bingham 1992, Dunaway and Fleischman 1995 and Dunaway and Fleischman *In prep*).

Under the NCSMP (5 AAC 06.361, adopted 1/92, amended 12/94) the sport fishery is managed for a guideline harvest of 5,000. The guideline does not apply if the inriver abundance exceeds 75,000. If the inriver return falls below 65,000, then restrictive actions are called for in the sport fishery. The sport fishery is to be closed if the inriver return falls below 40,000.

Regulations governing the sport fishery have become increasingly restrictive as the fishery has developed. A chronology of significant regulation changes follows:

- Bristol Bay bag and possession limit was 10 salmon (all species combined) daily.

- Bag limits for the Bristol Bay area were dropped to 5 chinook salmon per day and in possession, of which only 2 could be over 26 inches in length.
- Bag and possession limits dropped to 3 per day, only 2 over 28 inches in length.
- Sport season established from January 1 to July 25. Spawning season closure adopted to afford drainage-wide protection to spawning chinook salmon stocks.
- Gear restricted to single-hook artificial lures for the portion of the Mulchatna River between the Koktuli and Stuyahok rivers.
- *Nushagak-Mulchatna Chinook Salmon Management Plan* (5 AAC 06.361) is adopted.
- *Nushagak-Mulchatna Chinook Salmon Management Plan* (5 AAC 06.361) is amended, setting the sport allocation as a guideline harvest rather than a cap.

Bag and possession limits for Nushagak chinook salmon are currently 3 per day, 2 of which may be over 28 inches (ADF&G 1997).

SONAR PERFORMANCE

From 1966 to 1985, escapement into the Nushagak River was estimated by aerial surveys. In 1986, a sonar project replaced aerial surveys as the primary method to estimate chinook salmon escapement. The sonar project provides estimates of the total number of chinook salmon entering the river, while spawning escapement is calculated by subtracting upriver sport and subsistence harvests from the sonar estimate.

In 1997, chinook salmon abundance estimated by the Nushagak River sonar differed substantially from aerial survey estimates. Aerial surveyors observed 41,700 spawning chinook salmon in the Nushagak River drainage. This observation is greater than the sonar count and did not take into account portions of the river not surveyed, effects of spawner stream life and visibility of salmon to the aerial surveyor. It did take into account upriver harvests. Based on the aerial survey results, the spawning escapement was estimated at 82,000 chinook, or twice the sonar count. Management actions tied to the sonar count resulted in substantial restrictions to the sport fishery.

The department attributes the problem experienced in 1997 to low water levels, slow water velocities and high water temperatures. A distribution study conducted during the fall documented a substantial portion of the coho migration offshore of the sonar beams. It is likely that these conditions caused chinook salmon to pass offshore of the sonar beam as well.

In 1998 and following years, the department will assess offshore distribution for all species of salmon as an integral part of the sonar project, with the objective of estimating the proportion of chinook, coho and other salmon species that migrate offshore of the sonar beam and to define how variable the offshore component is between years. Results will be used to determine the viability of the sonar as a tool for counting chinook and coho salmon in the Nushagak River.

MANAGEMENT PERFORMANCE UNDER THE NUSHAGAK-MULCHATNA CHINOOK SALMON MANAGEMENT PLAN

COMMERCIAL FISHERY

Since 1992, the commercial fishery was managed to achieve the inriver goal of 75,000 fish at the sonar, as specified in the NCSMP. From 1986 to 1991, the Nushagak District commercial salmon fishery was also managed to achieve a provisional escapement goal of 75,000 as measured by sonar.

The department adjusts fishing time and area in an attempt to harvest chinook salmon surplus to the inriver goal. Management decisions are based on the preseason forecast and inseason indicators of run strength, including commercial harvest performance, subsistence harvest rates and inriver passage by the sonar. To maintain quality and value, chinook salmon are commercially harvested early in the run (June 8 to June 20) before the majority of fish discolor and become soft, and before many fish migrate inriver. Chinook escapement typically peaks 10 days after commercial harvests; only 15% of the inriver escapement is counted past the sonar when commercial harvests peak. This difference in run timing prohibits reliable inseason estimates of run size until the peak of the fishery. Therefore, early openings are justified on forecasted harvestable surplus and the need to maintain quality and value.

From 1986 through 1991, inriver abundance of chinook salmon was equally distributed above and below the inriver goal (Figure 9). From 1988 to 1991, the directed commercial fishery was essentially closed due to poor run sizes. The magnitude of inriver runs prior to 1992 was therefore largely dependent on total run strength. Inriver abundance estimates during this period ranged from 43,400 (-42%) to 104,351 (39%) and averaged 71,900 fish, or 4% below the inriver run goal. The difference between actual inriver runs and the inriver goal averaged 19%.

Directed commercial fishing resumed under the NCSMP in 1992. Since then, commercial fishing has targeted chinook salmon to take advantage of harvestable surplus. Fishery managers generally scheduled commercial fishing periods to follow inriver pulses of fish, thereby ensuring that untargeted fish migrate inriver prior to harvests. In 1992 and 1993, commercial fisheries were managed conservatively by limiting the number and duration of openings to ensure inriver escapements met or exceeded inriver goals in this "re-building" phase. From 1994 to 1996, the directed chinook fishery was managed more aggressively to achieve the inriver goal and provide the available surplus to the commercial fishery. Due to escapement quality problems in 1995 and 1996, commercial fishing periods in 1997 were scheduled after pulses of fish were observed moving into the river to reduce selectivity for large fish.

Since 1992, the goal was exceeded in all years except 1996. From 1992 to 1996, inriver abundance estimates averaged 10% above the inriver goal. Deviations from the inriver goal have ranged between $\pm 30\%$.

Biologically, inriver abundance from 1987 through 1997 has been within the range of escapements thought to provide the highest levels of yield.

SPORT FISHERY

The Nushagak chinook salmon sport fishery has been managed under the NCSMP since 1992. The management objective in the sport fishery is dependent upon the projected inriver abundance

and therefore may be different between years. In seasons where the inriver goal of 75,000 is exceeded then the sport harvest may exceed the guideline of 5,000. When the inriver return is between 65,000 and 75,000 then the sport harvest is to average 5,000. If the inriver return falls below 65,000 the sport harvest is to be less than 5,000 and estimated spawning escapement should not dip below 40,000 after considering the removal by inriver subsistence fisheries. Table 5 shows the management target, the actions taken and the ultimate performance under the plan in managing the sport fishery. Since 1992, the sport fishery has been managed in such a manner as to have met the management objectives defined by the plan.

Table 5.-Sport fish management performance under the Nushagak-Mulchatna Chinook Salmon Management Plan, 1992-1997.

YEAR	SONAR EST. ABUNDANCE	SPORT FISH TARGET	MANAGEMENT ACTION TAKEN	SPORT FISH HARVEST
1992	82,848	5,000 Cap	None	4,755
1993	97,812	> 5,000	None	5,899
1994	95,954	> 5,000	None	10,626
1995	85,622	< 5,000	None	4,951
1996	52,127	< 5,000	Preseason bag limit dropped to one. Inseason Restricted to Catch and Release	2,144
1997	41,000	< 5,000	Preseason bag limit dropped to one. Inseason Restricted to Catch and Release	2,500

SUBSISTENCE FISHERY

Nushagak chinook salmon support an important and growing subsistence fishery. Regulations governing the subsistence fishery provide for a 7-day per week opportunity with set gillnets of either 10 or 25 fathoms depending on the location fished. Significant effort and catches occur on the beaches around Dillingham, at subsistence fish camps at Lewis Point, and up the Nushagak River generally around village sites. On July 2, the subsistence fishery in the Dillingham area is reduced to a Monday, Wednesday, Friday schedule in response to local concern over potential sockeye wastage. Subsistence harvests have grown and appear to be independent of run size. Long-term harvests (1966-1996) averaged 9,500 chinook (Table 1). In the recent 5 years (1992-1996) subsistence harvests have averaged 15,300. The portion of the harvest taken from subsistence has increased from 11% to 16% for the before mentioned periods (Table 1).

The NCSMP calls for restrictions in the subsistence fishery only when inriver runs are projected to be less than 40,000 fish. Since inriver return has exceeded 40,000 chinook salmon each year, the subsistence fishery has not been restricted for the conservation of chinook salmon.

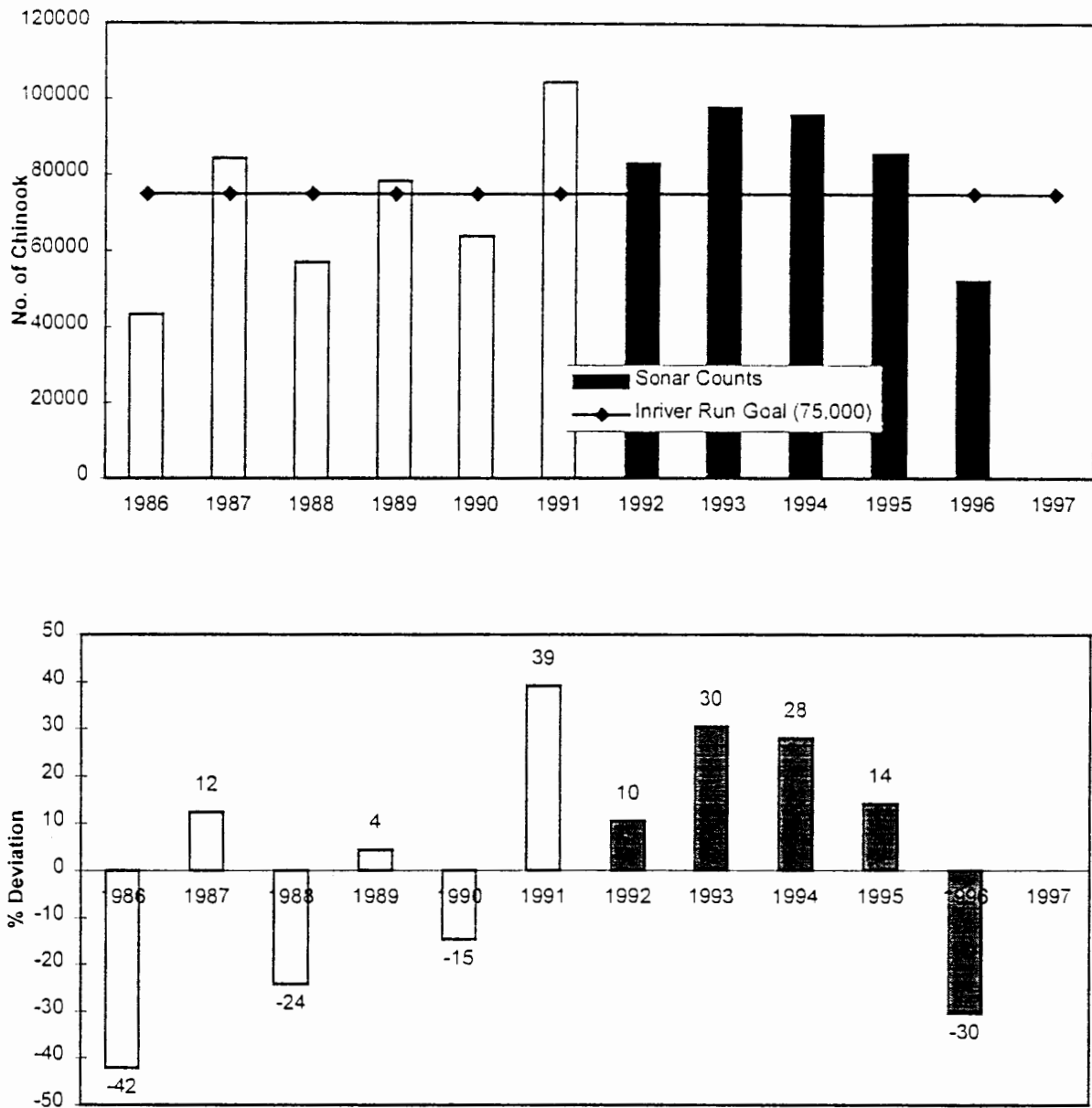


Figure 9.-Inriver runs of Nushagak River chinook salmon versus inriver run goal, 1986-1997.

SUMMARY OF THE 1997 FISHERIES

OUTLOOK

The 1997 Nushagak District chinook salmon forecast was 156,000. Harvest potential in the sport fishery, given an inriver abundance of 75,000 fish, was estimated to be 10,000 chinook salmon, or 50% greater than the guideline harvest level. On January 30, 1997, department staff issued a preseason emergency order reducing the bag and possession limit for Nushagak chinook from 3

per day, of which 2 may be over 28 inches, to 1, no size limit. The early restriction was intended to reduce the harvest potential in the sport fishery by 50% to keep the harvest in line with the guideline level prescribed in the management plan.

Given the forecast of 156,000, an inriver goal of 75,000, and an expected downriver subsistence harvest of 12,000, about 69,000 chinook salmon were potentially available for commercial harvest. Approximately 45,000 fish were available for harvest in the directed commercial fishery, with the balance expected to be taken during the sockeye fishery. A strategy of fishing the back-side of pushes of chinook into the Nushagak River was applied to address the concern for escapement quality observed in 1995 and 1996. Allowing untargeted fish into the river was intended to lessen the effects of selectivity in the commercial fishery and allow untargeted fish, with a desirable size and age distribution, to enter the river.

CFMD initiated a subsistence monitoring project at Lewis Point in 1997 (Browning *In prep*) to improve the ability to detect when chinook salmon move into the river. A fishery survey of the Nushagak and Mulchatna chinook salmon sport fishery was also conducted in 1997 (Dunaway and Fleischman *In prep*). Staff interviewed anglers in the Portage Creek area and in the Mulchatna River between the Stuyahok and Koktuli rivers. Objectives included the estimation of chinook harvest below the sonar, the estimation of demographic information, size composition of harvested chinook salmon, and the harvest characteristics of guides and other anglers. The survey was conducted as planned for the duration of the fisheries.

INSEASON MANAGEMENT

Two directed commercial periods, for a total of 16 hours, were allowed with a peak effort of 278 boats and 58 set nets fished. These openings were based on the preseason forecast and inseason escapement and subsistence harvest rates and age composition analysis that indicated actual run strength was at least as large as the forecasted run. Commercial harvest during these directed periods accounted for 39,000 chinook salmon. Another 25,300 were taken during the sockeye fishery. Total commercial harvest for the season was 64,294 chinook salmon, or slightly less than the available commercial harvest, based on the preseason forecast.

By June 27 inriver passage was estimated at only 26,000 chinook salmon, and based on sonar projections, a passage of less than 65,000 was anticipated for the season. The department announced a catch-and-release restriction for the Nushagak and Mulchatna rivers effective June 30 and continuing through the remainder of the season. Sport effort appeared to drop significantly in the Portage Creek area and the restriction significantly affected participation in the Ekwok and Mulchatna areas. Final sonar passage for chinook was estimated at about 41,000.

In early August escapement surveys of the majority of the spawning areas were flown and chinook escapement was estimated to be 82,000 chinook salmon, or twice the estimated sonar passage. Significant chinook salmon were missed by the sonar and the estimate of spawning escapement was based on aerial survey results.

The actual return of chinook salmon to the Nushagak drainage in 1997 was approximately 163,800 fish, very close to forecast (Table 1). Commercial harvest totaled 64,300 chinook salmon and subsistence harvest was estimated to be 15,000 chinook salmon. Roughly 2,500 chinook salmon are estimated to have been harvested in the sport fishery.

ISSUES AFFECTING SPORT FISH MANAGEMENT

There are several issues that currently affect management of the sport fishery and therefore affect sport fishing opportunity for Nushagak chinook salmon. These issues are addressed in the form of seven Board of Fisheries proposals that directly address the management of the Nushagak chinook salmon fisheries and an additional three that indirectly affect sport fishing opportunity for this fishery.

The ability to keep the sport fishery within the 5,000 fish allocation

Through inseason management efforts the sport harvest of chinook salmon has averaged 5,675 during the last 5 years. However, under the current level of effort and current regulations, department staff believe the harvest potential of the Nushagak chinook salmon sport fishery is approximately 10,000 fish, given an inriver abundance of 75,000. Sport fishing effort in the Nushagak has increased approximately 9% per year during the last 5 years. Assuming increasing effort and harvest potential are related, in 3 years (one more Board cycle) the harvest potential under current regulations is expected to be approximately 13,000 chinook salmon. If the Board decides to leave the sport allocation at 5,000, and desires to make the regulations stable for a 3-year period, then the current harvest potential will need to be reduced by approximately 60%. A number of proposals are before the Board to address this issue; including establishment of annual limits, reduced daily bag and possession limits, elimination of bait, restrictions on the activities of guides, and reducing areas open to sport harvest of chinook salmon.

Management precision and the effect on sport fishing opportunity

Under the current management plan the commercial fishery is to be managed for an inriver return of 75,000 chinook salmon. Fish surplus to the 75,000 are to be taken in the commercial fishery. Decisions to open and close the commercial fishery in an effort to harvest chinook salmon surplus to the 75,000 are based on the preseason forecast, commercial fishery performance, subsistence catch strength, and sonar-estimated inriver abundance. As with all management tools, there is a level of error associated with each of the inseason indicators of run strength.

Past management provides an estimate of management precision associated with achieving the inriver goal. Deviations from inriver goal have ranged $\pm 30\%$ (approximately 22,000 chinook salmon) since 1992. Comparison of recent escapement levels to resulting returns found that a 30% variation has little biological consequence to future production.

The consequence of this level of management precision can be significant to the user groups. The management plan requires that the sport fishery be restricted when the inriver goal is undershot by 13%. In some cases, this may equate to one commercial fishing period. At current levels of participation and harvest potential, it has been necessary to restrict the sport fishery to catch-and-release only in the 1996 and 1997 seasons. This action has proven to be disruptive to recreational anglers and the sport fishing industry.

To address this issue the Board has two options. First, the inriver goal could be increased, providing a buffer between the 65,000-fish action point found in the plan and the inriver target for the commercial fishery. This approach carries with it the cost of lost harvest opportunity in the commercial fishery and increases the risk of exceeding 100,000 spawners. An alternative approach may be to "desensitize" the management plan by lowering the action point at which the

sport fishery is restricted. As worded, the current plan specifies restrictions in the sport fishery at 65,000, well within the range of escapements that produce high yield. By moving the trigger to some lower number, but still well within the range of high yield, a buffer can be built into the plan with no reallocation of resources. If the plan is desensitized, a concern of the department is that the lower trigger does not jeopardize the quality of escapement.

The quality of escapement

While it is not specifically stated, the 65,000 fish biological escapement goal for Nushagak chinook salmon carries with it the assumption of adequate levels of egg-bearing females in the escapement to maintain productivity.

Inriver users expressed significant concern regarding the unusually high proportion of jacks (small males) and a scarcity of females they observed in the 1995 and 1996 returns. Prior to the 1997 season, the department examined size and age composition of chinook salmon captures at the sonar site and determined: (1) the number of female spawners was less than desired for adequate egg deposition in 1995, and (2) a pattern was evident where age composition of early-season escapement differs substantially from age composition later in the run. These problems appeared linked to size-selectivity of the fisheries, and if left unresolved, could result in decreased future yields of Nushagak River chinook salmon.

To avoid low proportions of females in the 1997 escapement, the department limited commercial fishing openings to after a pulse of chinook salmon had entered the river. The intent was to allow untouched portions of the run with "natural" size and age compositions to pass through the commercial district and, ultimately, onto the spawning grounds. This strategy appears to have worked in that a greater number of productive females appear to have escaped than in the previous 2 years.

Two proposals that seek to redefine the BEG in terms of large chinook salmon are before the Board for consideration. As established in the department's analysis, the current BEG adequately addresses the differences in age composition observed in recent years.

Management staff recognize the importance of putting large fish into the escapement, and intend to monitor escapement performance as prescribed in the Escapement Goal Policy. Staff believe that the current BEG of 65,000 is adequate to accommodate variations in annual size and sex composition. Staff intend to ensure sufficient numbers of large spawners through inseason management of the chinook fisheries.

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